

Critical Thoughts on Cosmology

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Abstract. An overview is given in section 1, of uncertain building blocks of present-day cosmologies. Thereafter, these edited lecture notes deal with the following four special problems: (1) They advertise Wiltshire's result – making 'dark energy' obsolete – that accelerated cosmic expansion may be an artefact, due to an incorrect evaluation of the cosmic timescale in a Universe whose bulk matter is inhomogeneously distributed. (2) They cast doubt on Hawking's prediction of black-hole evaporation. (3) They point at various inconsistencies of the black-hole paradigm, in favour of nuclear-burning central engines of AGN. (4) They re-interpret (a best case of) 'anomalous redshifts' as non-cosmological, kinematic redshifts in strong jet sources.

Keywords: Hawking entropy, Hawking radiation, cold Big Bang, dark energy, dark matter, supernovae, cosmic rays, γ -ray bursts, jets, burning disks, anomalous redshifts.

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1. BASICS OF COSMOLOGY

The literature on Cosmology is nowadays quite heterogeneous; how certain are we concerning its basic assumptions? When we try to explore our cosmic past by evaluating all the astronomical observations, our confidence is strengthened by the fact that:

(0) All the dimension-less *fundamental constants* have been constant throughout cosmic epochs (as judged by their redshift of recession), at a level of $\lesssim 10^{-5}$ (Kaneekar et al, 2005). I.e. we feel encouraged to apply to cosmology our locally secured laws of physics. We then have to worry about the proper field equations:

(1) Should cosmology be based on Einstein's *Theory of General Relativity*, with or without the cosmological (Λ) term, called "dark energy" in more modern language? Authors like David Crawford (2008), Wilfred Sorrell (2006), or Tom van Flandern prefer *Newtonian* cosmologies. Hoyle et al (2000) think they require *continuous creation* of matter, at near-singular sites. Does the Universe contain "dark (non-baryonic) matter", as is generally believed – not necessarily, though, by Erwin de Blok (McGaugh and de Blok, 1998)? Authors like David Wiltshire (2007a,b) argue that the mystery of *dark energy* is not required once we evaluate our backward lightcones correctly, taking care of the (observed) inhomogeneous distribution of the field-generating matter; see also Ellis (2008).

(2) Once we agree on the field equations – with or without a certain number of free parameters – there is the unknown initial state: Was there a "big bang" singular beginning? Was it *hot* – as is usually assumed, for no other than simplicity's sake – or was it *cold*, as preferred by David Layzer (1990)? To me, a cold beginning sounds like the *most plausible* initial condition. Moreover, I expect a large fraction of the 'primordial' cosmic helium to be formed in the central engines of all the galaxies during

their active epochs, arguing against excessive primordial nuclear burning of hydrogen (during the first three minutes; Kundt 2008a).

(3) Within this cosmological framework of assumptions, we want to understand how the network of cosmic *density fluctuations* was formed – of ‘voids’ surrounded by ‘walls’ – with its *galaxies*, and *clusters* of galaxies within which large-scale *magnetic fields* and *stars* form, shine, blow winds, and explode, and whose centers turn (non-thermally) active quasi-periodically, with bursts of star formation, and with *QSOs* at their very centers, with their Broad-Line Regions (BLRs), and occasional gigantic twin jets, Narrow-Line Regions (NLRs), and Extended Shell Regions (ESRs). How far has our knowledge about them advanced; are we ready to cope with them? The building blocks contain (the mechanism of the various) *supernova explosions* (Kundt 2008b), *jet formation* (Kundt & Krishna 2004), *cosmic-ray* production (by the galactic throttled pulsars? Kundt 2009), *gamma-ray bursts* (again by the throttled pulsars? Kundt 2009), anomalous (*non-cosmological?*) *redshifts* (Arp, 2008), and a thorough understanding of the *fluctuation structure* of the (2.725 K) background radiation: How much of it is imprinted by foreground structure, most noticeably by the solar system, as is suggested by its quadrupole and octupole moment (Thyrso Villela, these proceedings; but also Fixsen 2003)? See also Kundt (2005) for preferred interpretations.

(4) Literature on cosmology does not only deal with the items listed in paragraph (3), but also with the possible formation of *black holes*, with their *entropy*, and with their *radiation* (in particular when of low mass), (Carroll 2008). None of them may be realistic, or even rightly claimed (Belinski 2006, Leblanc 2002); I will come back to them in section 3. Carroll also talks about a *quantization of space-time geometry*; with what (measurable) effects in mind? I cannot see any astronomical observation that would (be able to) measure space-time quantization. Astronomical observations never approach the frontier between classical and quantum behaviour of its targets. Independently, I cannot see a consistent fusion of the two theories, cf. (Kundt 2007). Quantization celebrates its successes whenever the sizes of particles shrink inside the ranges of their guiding waves. It controls the equation of state of the substratum, but should leave the spacetime metric unquantized.

This compilation of edited lecture notes will focus on a number of controversial items which are of relevance to modern cosmology, as has just been explained. *Section 2* will present an intuitive explanation of how Wiltshire has rendered ‘*dark energy*’ obsolete: smoothening the spacetime geometry does not commute with evaluating its past lightcones, and timing. *Section 3* repeats my earlier (1976) objection to Hawking’s definition of the term ‘*BH entropy*’: his expression measures the entropy of the BH’s evaporation products (if it dissolved via radiation), not that of a newly formed BH. *Section 4* summarizes my lack of conviction of the presence of supermassive black holes at the centers of all the (large) galaxies, in favour of (nuclear) ‘*burning disks*’ (BDs). And *section 5* deals with the phenomenon of *anomalous redshifts* which have stood at the cradle of non-Big-Bang cosmologies.

2. TIME KEEPING IN AN INHOMOGENEOUS UNIVERSE

‘Dark energy’ is the name introduced by Mike Turner, for what had been called the ‘ Λ term’, or ‘cosmological term’ in Einstein’s field equations for more than half a century, a term that had no obvious physical meaning – at least not in the laboratory – but that could not be rejected either from the cosmological field equations if one was looking for the most general second-order equations derivable from a scalar Lagrangean. During the last decade, measurements with increasing accuracy of the present average cosmic expansion signalled an increasing expansion rate of the substratum – an acceleration – in obvious violation of energy conservation: An expanding cloud of self-gravitating objects should decelerate. This misbehaviour of cosmological kinematics urged Turner to introduce his cryptic – and even somewhat misleading – name “dark energy” for the Λ -term: Λ does not correspond to an energy density because it exerts a negative pressure, forbidden by the classical energy inequalities for laboratory substance (e.g. Kundt 1972); it is a non-energy, or at best a quasi-energy.

For this reason, it struck me as a salvation of (serious) cosmology when I read about David Wiltshire’s dismissing dark energy (Wiltshire 2007a,b, Ellis 2008). His thesis is simple and convincing: Cosmology had hitherto been evaluated wrongly, by ignoring the inhomogeneous distribution of its substratum. We know Shapiro’s ‘time delay’ effect in the solar system, and in close neutron-star binaries: Signals passing close to heavy objects (stars, galaxies) reach a distant observer with a certain delay. In the same vein, when we measure cosmic expansion, we use light rays which have propagated through an inhomogeneous Universe, with voids and walls, sometimes propagating through near-vacuum patches (voids), and sometimes skimming heavy mass concentrations (clusters of galaxies, in the walls). Clearly, the formulae derived for a homogeneous cosmological model cannot be expected to describe our observations correctly, due to non-linearities. Our local time scale, described by our (timelike) worldline, inside our (massive) Galaxy, has to be referred to the average cosmic timescale via intersections with successive null geodesics lying on past light cones, and connecting us to distant sources in the past. There is no a priori reason why these two timescales should be the same. A deviation is expected, an acceleration, whose sign we must calculate, and whose magnitude must likewise be calculated. It is a cumulative effect, to be obtained by integration over large spacetime distances. Wiltshire has done such calculations, and claims that their result describes the observed seemingly accelerated expansion, without a Λ -term in the field equations. All we have to do is evaluate our observations rigorously.

Wiltshire’s papers are not easy to read; they are long. But fig.1 should do in explaining what he has done: It sketches a significant fraction of our cosmic environment, in an almost metrical (1+1)-dim spacetime slice through our Universe, whose metric is indicated – upto an arbitrary conformal distortion – by a number of past lightcones, with their tips at the center of our local world tube (of higher than average mass density). These lightcones are steeper when traversing the walls, and shallower in between, because signals propagate more slowly – as sensed by a distant observer – when they move through more densely populated domains than otherwise. Precisely this locally inhomogeneous geometry gives rise to a non-trivial global effect, when measuring our (average) past spacetime geometry. No dark mystery is required for its description.

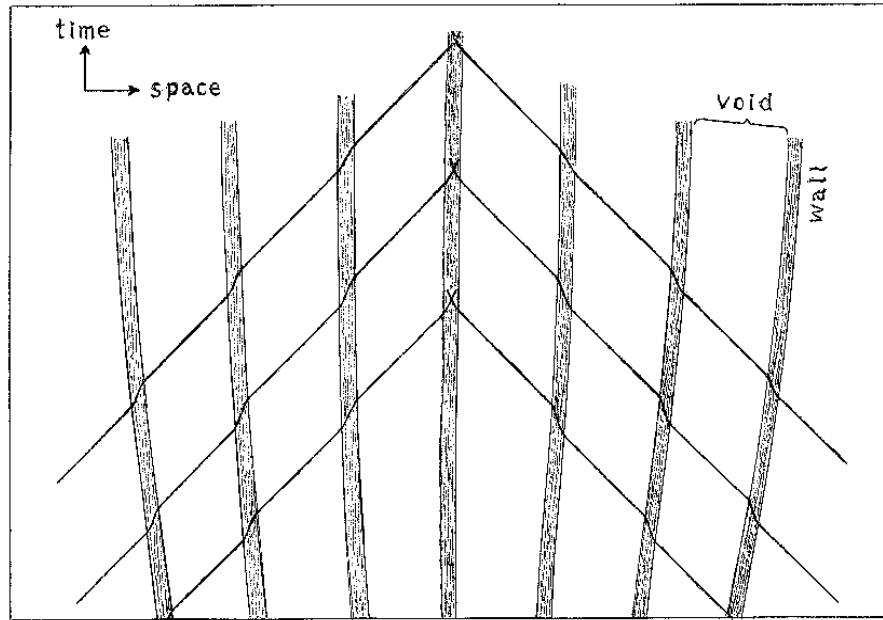


FIGURE 1. (1+1)-dim radial spacetime section of our past cosmic lightcone, in non-Minkowskian coordinates: Matter is concentrated in non-expanding (timelike) worldtubes separated by expanding cosmic voids. The variable delay of cosmic time inside world tubes is indicated by wiggles in the past global light cones.

3. ENTROPY OF A BLACK HOLE

Let me begin this section with a (2+1)-dim sketch of the spacetime geometry of a forming (non-rotating) BH which is assumed to subsequently dissolve again by heating up, radiating, shrinking, and finally exploding. The BH is assumed to form from an approximately spherical (supercritical) mass concentration via collapse under its own gravity. Similar in spirit to fig.1, fig.2 is drawn in asymptotically (2+1)-dim Minkowskian coordinates, assuming spherical symmetry of 3-space, but metrically distorted near its center in such a way that the causal structure has to be read off the drawn-in local light cones, which point increasingly inward during increasing approach of the symmetry axis of the figure. This symmetry axis represents the history of the forming BH's center, which at late times – after the BH's assumed complete evaporation – turns again into the center of a Minkowskian domain. During collapse, the contracting substratum gives off all the higher multipole moments of its mass distribution via radiation (of both electromagnetic and gravitational waves), and contracts deeply inside its 'horizon', which is drawn (in gray) in the shape of a slowly contracting (lightlike) cylinder. A distant observer sees the surface of the contracting mass concentration until it crosses its horizon. Thereafter, he or she receives the shrinking hole's redshifted evaporation radiation, for a very long time, whose mass decreases slowly – towards $\lesssim 10^9 \text{ g}$ – and whose temperature rises slowly, and eventually peaks abruptly, above 10^{17} K , in the form of a final flash, of duration of the order of a second.

This history of a BH just described, and sketched in figs.2,3, was advocated by

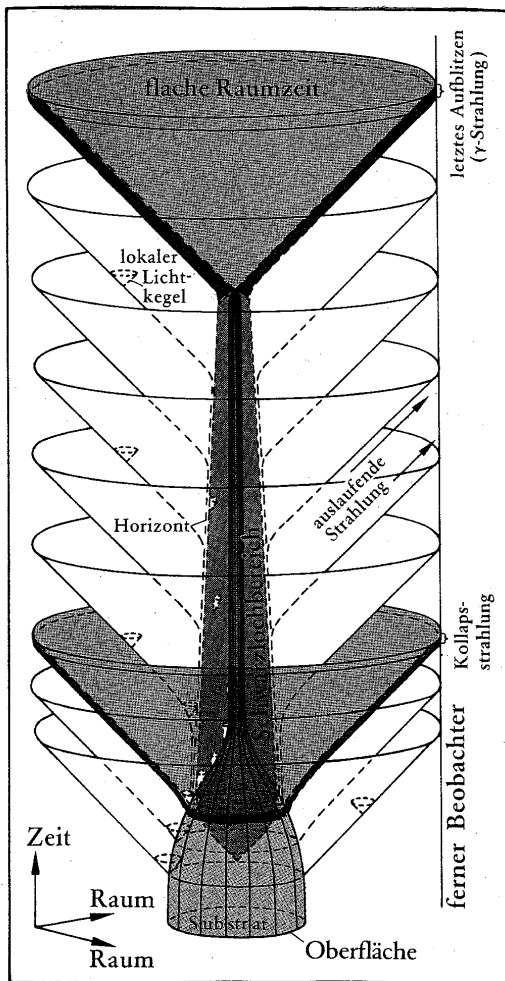
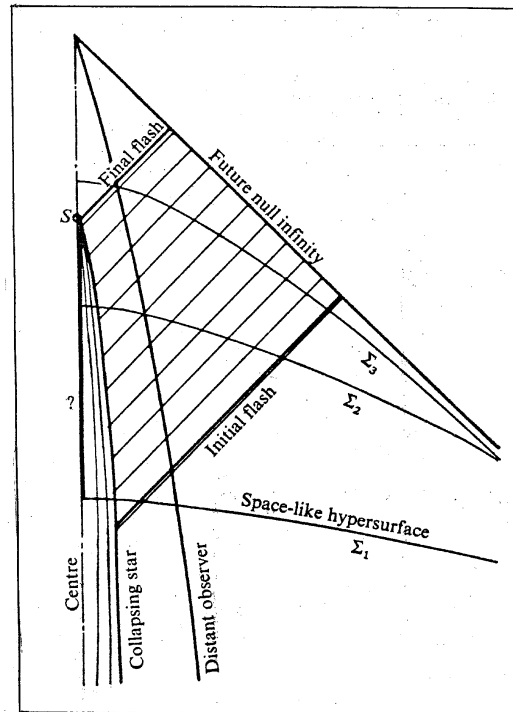


FIGURE 2. (2+1)-dim spacetime diagram of the history of a forming, and subsequently evaporating stellar-mass BH, according to Hawking's prediction (1974, 1975). Spherical symmetry is assumed, and coordinates are chosen Minkowskian at large distances from the center, whilst strong distortions near the center are indicated by (small) local light-cones. In these coordinates, the BH domain proper is the dark-gray elongated central al-



most cylinder, which terminates during the final flash. A distant observer sees the BH formation via its very short burst of radiation during formation, when all the non-fitting higher multipole moments are disposed of, then via its extremely faint evaporation radiation, for almost eternal times, and eventually via its short, very hot final flash of disintegration.

FIGURE 3. (1+1)-dim radial spacetime section through the geometry of fig.2, now in conformally distorted (Penrose) coordinates for which future null infinity has been transformed to finite distances, and all lightrays propagate at $\pm 45^\circ$. A set of spacelike hypersurfaces Σ_j is drawn, to which a distant observer would refer his or her entropy estimates.

Stephen Hawking in 1974, and elaborated by him in 1975, and we all trusted it, throughout the world. We trusted him and his associates, even though we did not understand the – highly non-classical – mechanism by which some strongly curved spacetime domain (around the BH) could generate outgoing electromagnetic radiation, and cause its enclosed volume to shrink in mass, size, and inverse temperature. Only now at this School,

34 years later, do I learn from Belinski (2006) and Leblanc (2002, recited) that all these expectations may have been premature, and unrealistic. That a BH, should it form, will not have a temperature, and will not evaporate. It will just sit and wait and grow by accretion from its surroundings.

Even though in 1975, I trusted Hawking's BH evaporation scenario, I disagreed with him on the meaning of what he called "BH entropy". My objections appeared finally in print, in 1976, with 11 distorting printing errors, and were mostly ignored by the scientific community. In that publication, I compared a forming stellar-mass BH with a forming white dwarf, or neutron star, and showed that all those compact stellar remnants (under collapse) had small entropies, smaller than the material from which they had formed, and that Hawking's so-called "BH entropy" agreed with that of the hole's expected randomized evaporation product (after some 10^{67} yr), a huge bath of radio waves of wavelength some 20 Km. Ever since then, string theorists have been proud of being able to rederive this expression, not worrying about its physical meaning. As Constantin Tsallis has shown, there exist large classes of functions with the (reasonable) positivity and convexity properties of the standard entropy in thermodynamics, though violating additivity (Boon and Tsallis, 2005; they use the word "nonextensive" for "non-additive"). Hawking's is one of them; it is quadratic in the BH's mass, not linear. The relevant thermodynamic formulae will soon follow.

Before their presentation, it will be helpful to redraw fig.2 in a different (distorted) way, leaving the local lightcones at $\pm 45^\circ$. Such conformally distorted diagrams can map infinity onto finite surfaces; they leave spacelike surfaces weakly inclined ($< 45^\circ$), and timelike surfaces strongly inclined ($> 45^\circ$) w.r.t. the time axis. Fig.3 is a redrawing of fig.2, but only for (1+1)-dim meridional sections. It shows the set of spacelike hypersurfaces Σ_j for whose material contents I shall calculate the successive entropies S_j contained in them. Note that quantum cosmology proposes yet different expressions – likewise called "entropy" – which do not vanish for vanishing particle number densities (Carroll 2008); I do not understand their physical meaning. They violate the strong equivalence principle.

We are now ready to calculate the relevant entropies S_j . Independently of whether we choose the phenomenological approach of box thermodynamics, with $dS := (dU + pdV)/kT$, with U standing for internal energy, $p :=$ pressure, and $V :=$ volume, or the statistical mechanics approach $S/Nk := -\langle W, \ln(W) \rangle$, with $N :=$ number of particles, and $W :=$ the canonical equilibrium distribution for a homogeneous gas of number density n at temperature T , the textbooks tell us that

$$S = N k s \quad \text{with} \quad s = 5/2 + \ln(1 / n \lambda_{th}^3) \in (0, 90) \quad (1)$$

holds for a non-quantum, non-relativistic (hydrogen) gas whose thermal de Broglie wavelength reads $\lambda_{th} := h / \sqrt{2\pi m k T} = 10^{-10.3} \text{cm} / \sqrt{T_7}$ with $m = m(\text{proton})$. Note that for ordinary matter, the entropy density s takes small values, between 1 and 90 for non-quantum gases, but always positive, and never very large values; it can be considered of order unity in astrophysical applications. This formula can be easily generalized to Newtonian gases in a curved spacetime by integrating the entropy density s , moving

with 4-velocity u^a , over a space section Σ of differential 3-volume dx_a^* :

$$S(\Sigma) = \int_{\Sigma} s^a dx_a^* \quad \text{where} \quad s^a := s u^a . \quad (2)$$

For a hydrogen mass M inside Σ , (2) yields $S(M) = 10^{57} k (M / M_{\odot}) s(M) \lesssim 10^{59} k (M / M_{\odot})$.

These expressions are to be compared with Hawking's entropy expression for a non-rotating black hole of mass M , (Schwarzschild) radius $R = 2GM/c^2 = 10^{5.5} \text{cm} (M/M_{\odot})$, and temperature

$$T_{BH} := \hbar c^3 / 8\pi G M k = 10^{-7} \text{K} (M_{\odot} / M) , \quad (3)$$

which imply an evaporation time t_{ev} for blackbody radiation given by

$$t_{ev} = M c^2 / 4\pi R^2 \sigma_{SB} T_{BH}^4 \approx 10^{67} \text{yr} (M / M_{\odot})^3 . \quad (4)$$

This evaporation time shrinks to $t_{ev} = 1 \text{sec}$ for M shrinking to $10^{8.5} \text{g}$, at a BH temperature of $T_{BH} = 10^{17.8} \text{K}$, higher than any (effective) temperature reached yet in laboratory experiments, and therefore to be handled with some reservation. Still, order-of-magnitude-wise, it describes the general expectations since the late 70s. Hawking's entropy expression for a BH reads:

$$S_{BH} = 4\pi G M^2 k / \hbar \approx 10^{77} k (M / M_{\odot})^2 . \quad (5)$$

When divided by above entropy (2) of its constituent hydrogen mass, with $s(M) \lesssim 10^2$, it yields the announced result:

$$S_{BH} / S(M) = (m_p c^2 / h \nu_{\odot}) (2\pi / s(M)) (M / M_{\odot}) \approx 10^{19} (M / M_{\odot}) , \quad (6)$$

in which $\nu_{\odot} := c/2\pi R_{\odot} = 10^{4.2} \text{Hz}$ stands for the peak frequency of a solar-mass BH's decay radiation. The huge factor $(m_p c^2 / h \nu_{\odot}) = 10^{19}$ (for a solar mass $M = M_{\odot}$) measures the number of decay photons generated during the hole's 10^{67} years of decay: 10^{19} radio photons for (the energy of) one hydrogen atom. Clearly, this huge number has no physical relevance for a newly formed BH, only for its eventual decay product.

As already stated above, this eventual decay product may never form (Leblanc 2002, Belinski 2006), because BHs do not evaporate. But in the meantime – before this minority opinion has succeeded in replacing the textbook interpretation – above quantitative results can serve as a warning: that untested QFT results need not apply. Frontline physics need not always be reliable.

4. CENTRAL ENGINES OF ACTIVE GALAXIES

The brightest sources in the Universe are the central engines of (massive) galaxies – even with the GRBs included, which I purposely ignore in this communication, (cf. Kundt 2009) – whose luminosities can exceed those of their host galaxies by factors

of $\lesssim 10^2$. They are commonly thought to be powered by supermassive black holes, of masses $\lesssim 10^{10} M_\odot$, originally because of their huge radiative outputs, occasionally dwarfing their hosts, already at optical frequencies, but even more so at TeV photon energies.

- But are we permitted to assume that supermassive black holes have gigantic radiative efficiencies, of order $\lesssim 0.4$, rather than $\ll 10^{-3}$, expected on alternative grounds (see below)?
- And how did those black holes form in the first place? Have not centrifugal and pressure forces always exceeded the self attraction of central galactic-mass accumulations?
- Why have the masses of the observed central BHs decreased during cosmic epochs, from initial $\lesssim 10^{9.5} M_\odot$ to their present-day $\lesssim 10^7 M_\odot$, as shown by the statistics of the SDSSurvey (fig.4, Vestergaard et al 2008)?
- How could some of the most massive ones already form within $\lesssim 0.8$ Gyr after the Big Bang?
- Why do their masses scale as $10^{-2.85}$ times their bulge masses (Marconi and Hunt 2003)?
- How do they blow their gigantic winds, and why have those winds the chemistry of ashes from excessive nuclear burning, being $\gtrsim 10^2$ -fold metal enriched (upto Fe)?
- How do they generate their extremely hard spectra, (occasionally) peaking at \gtrsim TeV energies, even recorded (from PKS 2155-304) as minute-sharp, hour-scale bursts (Weekes 2007), whilst accreting black holes radiating at their Eddington rates are predicted to shine with blackbody temperatures of $\text{KeV}(M_\odot/M)^{1/4}$?
- Why are some of them distinctly underluminous?
- Why does their high γ -ray compactness not prevent them from forming jets, in the (10%) cases of their radio-loud subpopulation, via inverse-Compton losses?
- And, if all the astrophysical jet sources are generated by a universal type of engine – whose powerhouses are newly forming stars (like our Sun, in its past), forming (binary) white dwarfs, binary neutron stars, and AGN – this universal type of engine looks like a rotating magnet, not like a BH (Kundt and Krishna 2004).

None of these questions have ever been satisfactorily answered in the literature, as far as I know (Kundt 2002, 2008a). There always was the seemingly unsolved problem of the required energetics, thought to exceed the nuclear reservoir provided by the primordial hydrogen. This problem is absent in David Layzer's cold Big Bang approach. Explosive nuclear burning can take care of the gigantic mass ejections from the centers of galaxies, evidenced in the form of the BLR, NLR, and ESR, so that the CEs of the QSOs started massive at high redshifts, at $\lesssim 10^{10} M_\odot$, were repeatedly discharged during active cycles (of their hosts), and have presently shrunken to their (statistically) low masses of $\lesssim 10^7 M_\odot$, (fig.4). In this process, their metallicities will have grown steadily, via incomplete ejection of ashes, so that present-day activities occur at distinctly lower masses of the CEs; which I like to call BDs, "burning disks", or "flat stars". I conceive them as the continuous continuations of the well-known gaseous galactic disks, all the way to their centers, cf. fig.5. During spiral-in – at mass rates of $\lesssim M_\odot/\text{yr}$, roughly radius-independent for (large) galactic disks – matter accumulates in their centers until it reaches stellar densities, starts main-sequence burning, and eventually heats up to explosive nuclear burning, all the way to iron, with gigantic nuclear detonations seen in the form of quasar outbursts. For a galactic infall rate of $1 M_\odot/\text{yr}$, only 3 Myr have to pass for sending the present mass of Sgr A* into our Galactic center!

Mass-infall rates into the center compensate mass-ejection rates when integrated over a typical quasar cycle. The hot cores have radial extents between 10^{16}cm and $\lesssim 10^{14} \text{cm}$,

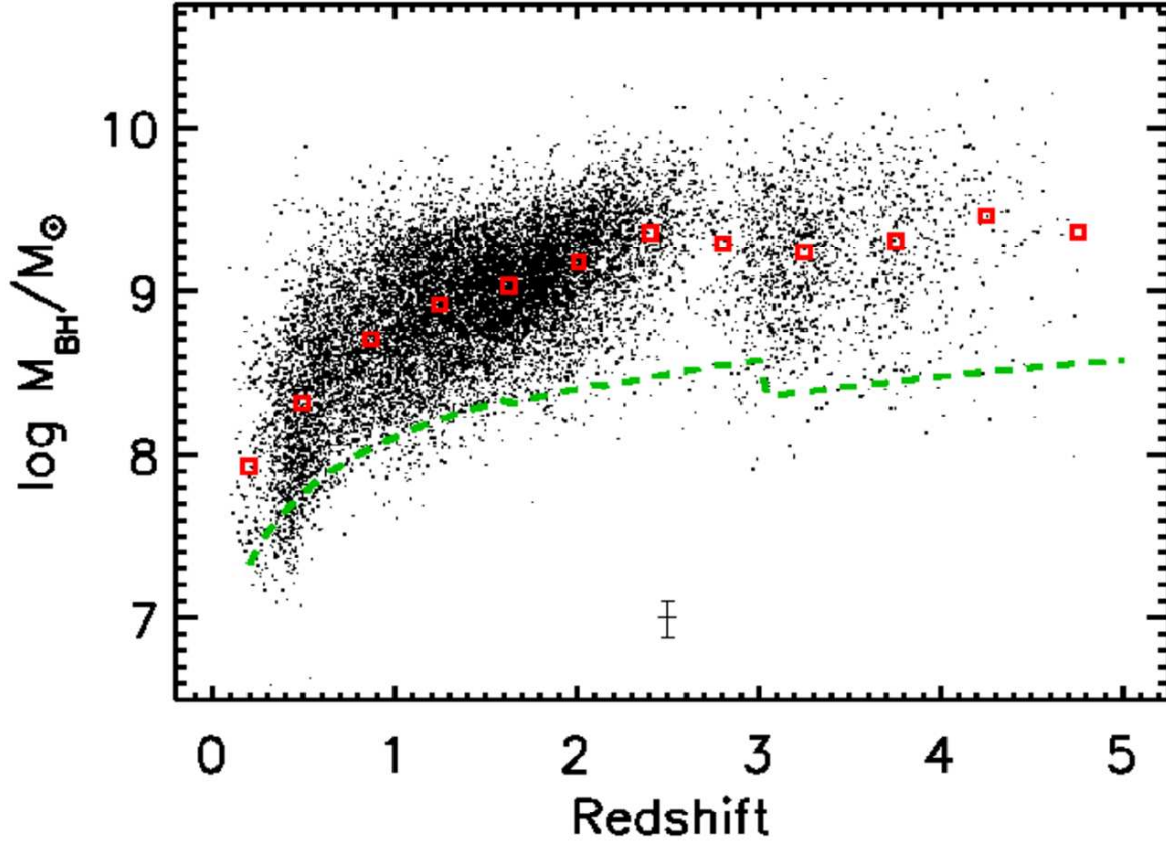


FIGURE 4. (Estimated) mass distribution of 14,584 quasar central engines (CEs) with $z \geq 0.2$, as functions of redshift z , from the Sloan Digital Sky Survey Data Release 3, within an effective sky area of 1644 deg^2 , taken from Vestergaard et al (2008). Squares denote median masses in each redshift bin. The dashed curve indicates faint SDSS flux limits.

vertical extents comparable to stellar diameters, and evolve chemically during spiral-in of their substratum (Kundt 2008a). The BDs are somewhat larger in extent than BHs (for the same mass), and have never reached instability towards gravitational collapse. During active cycles, their QPO variability timescales show a white power distribution, with an upper break frequency f of

$$f \lesssim 3 \text{ KHz } (M_{\odot}/M) \quad (7)$$

found by Remillard and McClintock (2006), which relation holds throughout more than nine orders of magnitude in mass, from the stellar-mass black-hole candidates to the most massive (well-sampled) CE of active galaxies. Famous examples for (7) are Sgr A* , with its bursts of duration $\lesssim 20 \text{ min}$ (for a CE mass of $10^{6.5} M_{\odot}$), and RE J1034+396, with its sampled one-hour quasi periodicity (and mass $10^7 M_{\odot}$), (Gierliński et al 2008). These preferred (shortest) QPO timescales are reminiscent of – but distinctly longer (10 times) than – the innermost Kepler periods of a BH. To me, they look like

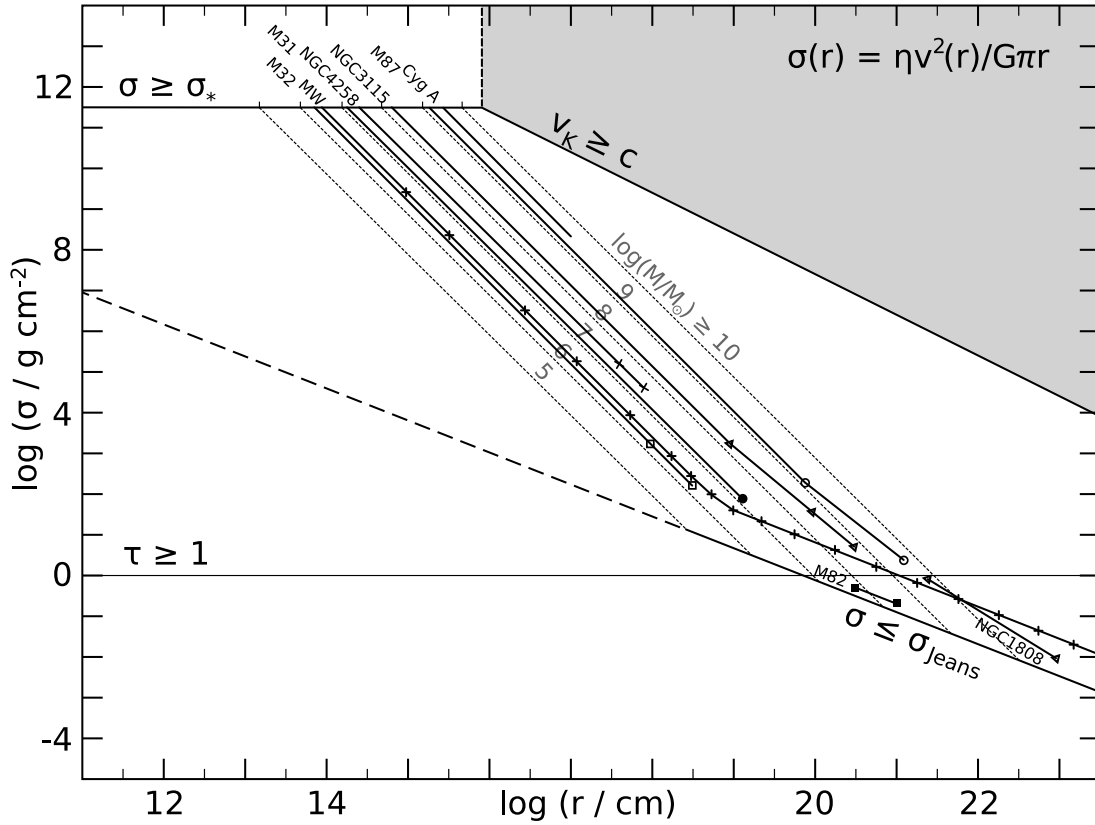


FIGURE 5. Complete rotation curves – with $10^{11}\text{cm} \leq r \leq 10^{23.5}\text{cm}$ – for a representative set of well-sampled galaxies, taken from (Kundt 2008a). For a better understanding of galactic centers, the ordinate presents average surface-mass density $\sigma(r) \lesssim v^2(r) / G \pi r$ (instead of rotational velocity $v(r)$): Whilst $\sigma(r)$ is tiny in the outer parts of a galaxy, where it is controlled by Jeans instability (to star formation), it grows considerably with decreasing r , but cannot exceed stellar values ($\sigma_* \approx 10^{11.5} \text{ g/cm}^2$), due to pressure forces, hence sets a bound on revolution speeds near the center. Observations indicate that galaxies have ringlike domains of insignificant (gravitating) mass density, between $\gtrsim 10^{14}\text{cm}$ and $\lesssim 10^{20}\text{cm}$, in which their rotation is solely controlled by the mass of their central engine (CE), and $M(r) = \text{const}$. Note that the detected CE masses all stay below the BH formation limit of $10^{10.5}M_\odot$ – marked in gray – beyond which they would enforce (among others) extremely relativistic galactic revolution speeds.

magnetospheric oscillation cycles. (Note that these engines can emit their power above TeV particle energies! Boosted via magnetic slingshots?).

Why do I mistrust the BH interpretation, (since $\gtrsim 30$ years)? As already explained, I cannot see the holes' formation mode: nature has provided hurdles, such as centrifugal forces, pressures, and detonations. Fig.5 shows that the BH rotation curves avoid the (upper right) BH formation regime; they stay below, in surface-mass density σ . They would touch it as soon as galactic revolution speeds, at some inner radius, would reach the speed of light, (and cause that region to flare!). Moreover, even if a BH

had somehow formed, and grown in mass to some $10^{10}M_{\odot}$, how would it interact with its surroundings? All ambient matter would be sucked into it, true, at speeds approaching the speed of light. But its tidal forces would be minute, because its curvature radius has heliospheric size, some $10^{15.5}\text{cm}$, too large to strain, or squeeze the infalling CSM towards significant densities. That infalling CSM would heat up a bit during its compression, though hardly above X-ray temperatures, and would moreover (i) reach infinity strongly redshifted. Such dissipative heating would be (ii) accretion-rate dependent, scaling as $n^2 d^3 x$, hence would tend to zero with a decreasing mass infall rate. For BHs above $10^8 M_{\odot}$, (iii) accretion at the Eddington rate would require supergalactic mass infall rates, $\dot{M} > M_{\odot}/\text{yr}$. Earlier estimates (by other people) applied accretion-disk efficiencies, and considered a potential energy of $0.42 \times$ rest energy at the innermost stable orbit of a maximally spinning BH. They ignored (iv) an optically thick zone around it, which would be swallowed whole, and which grows with increasing density n . To me, AGN observations never reveal radiated powers of the CE as large as 10^{-3} of its accreted power, in agreement with above considerations. Large efficiencies of BH accretion have never been demonstrated.

The best-studied CE of all is that of our Milky Way galaxy, Sgr A*, at a distance of $\lesssim 8.0$ Kpc, whose spectrum is almost white in power ($\nu S_{\nu} = \text{const}$) from 10^{12}Hz up to TeV energies, with an integrated power of $\gtrsim 10^{37}\text{erg/s}$ which may peak at GeV energies. It shows simultaneous daily bursts at radio and X-ray frequencies, of duration $\gtrsim 17\text{min}$. On 16 Nov. 2007, Frank Eisenhauer told us at Bonn that the (16yr) Kepler ellipse of star S2 around Sgr A* does not close, by 3^0 , which indicates the gravitational potential of a massive disk (instead of a pointlike BH). This indication is supported by a growing mass estimate of Sgr A* with increasing approach, between 2003 and 2007, from $10^{6.46}$ to $10^{6.58}$ or even $10^{6.63} M_{\odot}$, depending on the correct distance to it, which Reinhard Genzel reported as $d = 8.33$ Kpc (on 9 Jan. 2009). Note that d is used to convert angular velocities (on the sky) into transverse velocities in space, whilst it leaves Doppler velocities unaffected; again, this determination prefers a disklike gravitational potential to the (almost) Coulomb potential of a BH. These three worries will grow into certainties, or disappear, with the accumulating number of measurements during the coming years.

An independent signature of the BD character of Sgr A* is its gigantic wind, seen to blow radial tails from the windzones of $\gtrsim 8$ nearby stars, at distances $\lesssim 1\text{yr}$, and mapped in the redshifted light of extended Br α , and in the blueshifted light of Br γ , of mass rate some $10^{-2.5}M_{\odot}/\text{yr}$, and speed $\lesssim 10^3\text{Km/s}$, (Kundt 1990). No hole can expel more matter than you dump on it.

5. ANOMALOUS REDSHIFTS AND JETS

In this last section of ‘critical thoughts’, I dare touching upon one of the most tenacious worries in Cosmology, shared by Halton Arp, Fred Hoyle, Geoffrey and Margret Burbidge, Martín López Corredoira, and a few others, though ignored by the rest of the community: the many close associations, in the sky, of objects of vastly differing redshifts, the phenomenon of the “anomalous redshifts” (Hoyle et al 2000, Arp 2008). Are celestial redshifts always cosmological, or are they occasionally simply kinematic? In

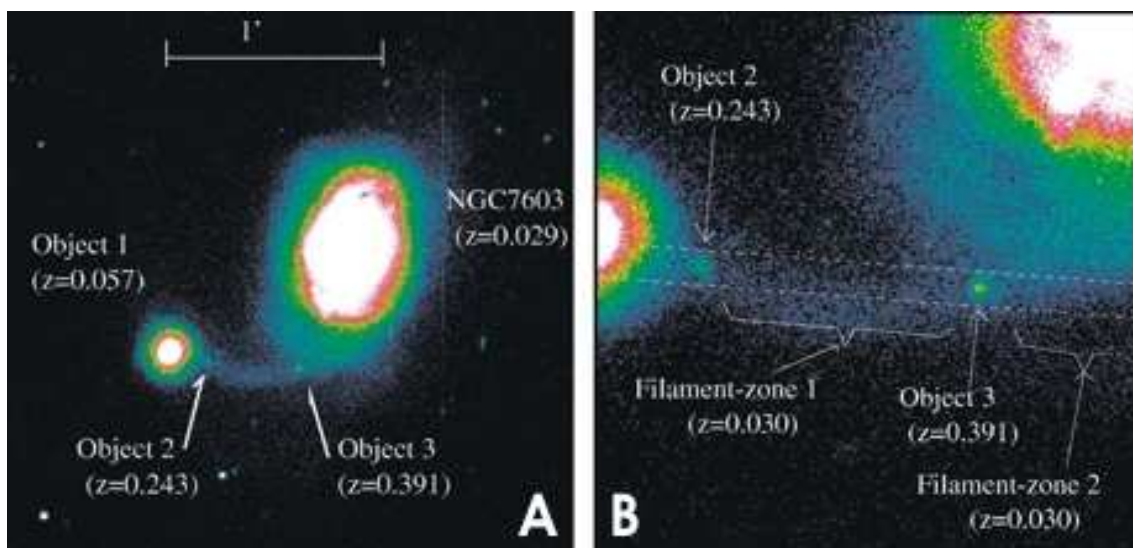


FIGURE 6. The celestial neighbourhood of the Seyfert 1 galaxy NGC 7603, taken from López-Corredoira and Gutiérrez (2002). It is connected by a curved, luminous bridge to an object 1 (also called NGC 7603B by them) of higher redshift but without emission lines. The bridge is slightly redshifted, again without emission lines, but contains two compact knots – called objects 2 and 3 in (2002) – of considerable redshifts and line-broadening, corresponding to FWHM speeds of $10^{3.2}$ Km/s, which were shown later (2004) to have FWHM extents of $\gtrsim 0.3''$. In the text I interpret NGC 7603B as the head of a receding jet, whose lobe is seen as the (mildly receding) bridge, and objects 2 and 3 as (fast) knots swept up by the (pair-plasma) jet.

the case of the GRBs, I maintain the latter, since more than 15 years (Kundt 2009). Here, for the first time, I maintain again the latter, for the "worst case" according to Arp, the Seyfert galaxy NGC 7603 and its near celestial neighbours; cf. López-Corredoira and Gutiérrez (2002, 2004).

Fig. 6A shows the celestial field around NGC 7603, measuring $2'$ across. The bright Seyfert 1 galaxy NGC 7603, of redshift $z = 0.029$ (and distance 124 Mpc, for $H_0 = 70$ Km/s Mpc), is connected to an object without emission lines, called NGC 7603B, at (larger) redshift $z = 0.057$, by a curved luminous bridge called "filament", of absorption redshift $z = 0.030$. The filament, in turn, contains two compact emission-line 'knots' of redshifts $z = 0.243$ and 0.391 , (from OII, H β , OIII, OI, NeIII, and H α , corresponding to velocity spreads of $\lesssim 10^{3.2}$ Km/s), which have been resolved and mapped in (2004), with FWHM $\gtrsim 0.3''$. Conservatively, the three knotlike objects have been interpreted as HII-galaxies, or NEL galaxies, at much larger distances.

But in my 1986 paper with Gopal Krishna, in which we elaborate on the bright jet source 3C 273, we find an approach velocity $c\beta$ of its head of order $\beta \approx z \approx 0.7$, and a non-detection of its inner part, and of its expected redshifted lobe. We conclude at an extremely strong, approaching galactic (pair-plasma) jet propagating through a rather thin circumstellar medium (CSM), so that its channel-wall material (or head) gets boosted to transrelativistic speeds. Another such blue-shifted jet source, CGCG 049-033, has been recently identified by Bagchi et al (2007); its receding lobe is unseen,

most likely for causality reasons.

I therefore like to interpret above NGC 7603 as a radio galaxy of which we see a receding "lobe" – called "filament" above – whose red-shifted head is NGC 7603B. The mildly redshifted lobe contains two fast, more strongly redshifted knots: the inner one of slightly higher redshift than the outer one, both of low column density, hence emission-line objects, with a considerable spread of velocities (caused by the jet's impacting at different strengths). Both knots and head are formed from ambient (channel-wall) material swept up by the extremely relativistic pair-plasma jet. Where is the opposite, blue-shifted lobe (of the twin jet)? It may well be bent around near the northwestern edge of NGC 7603, with both lobes forming a large "U" (open in 'downwind' direction). Alternatively, its blueshifted light may already have passed us. Note that when two objects are fired in opposite directions at relativistic speeds, a distant observer aligned with them will see the blueshifted object for a very short time only – when its flash passes him or her – whilst the redshifted object will stay visible for its whole lifetime. We thus expect to see many more redshifted knots than blueshifted knots, perhaps 10-times as many; two blueshifted ones were discussed above. I see no principle difficulty in identifying a number of high-velocity receding emission-line knots as luminous channel-wall material in receding lobes. Jet plasma is thought to move at large Lorentz factors ($\gtrsim 10^2$, Kundt and Krishna 2004), and occasionally imposes transrelativistic channel-wall speeds. Redshifts need not always be cosmological.

Why have corresponding blueshifted emission lines never been reported, from approaching jets? They may be difficult to detect: The knots and heads of the (relativistic!) jets are expected to emit their synchrotron radiation strongly in forward directions, whereas their (slowly moving) channel-wall material should radiate almost isotropically. Consequently, redshifted lines should come from a dark sky, whilst blueshifted lines should be superposed on a strong synchrotron continuum. Indeed, the radiation received from the blueshifted hotspots in 3C 33, Pictor A, and others may well be such superpositions: Simkin (1986), Simkin et al (1999), Tingay et al (2008). An absence of reports need not mean an absence of detections.

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